On Fraunhofer’s lines by Gustav Robert Kirchoff

Gustav Kirchhoff (1859) "Ueber die Fraunhofer'schen Linien" (On Fraunhofer's lines), Monatsbericht der Königlichen Preussische Akademie der Wissenschaften zu Berlin (Monthly report of the Royal Prussian Academy of Sciences in Berlin), 662–665.

Mr. Du Bois-Reymond sent a message from Mr. Prof. Kirchhoff on the Fraunhofer lines, received Heidelberg, October 20, 1859.

On the occasion of an unpublished investigation by Bunsen and myself in collaboration with the spectra of coloured flames, by which we have been able to discern the qualitative composition of complex mixtures from the sight of the spectrum of their flame, I have made some observations give an unexpected survey of the origin of the Fraunhofer lines, and conclude that they justify the substance of the atmosphere of the Sun and perhaps also of the brighter fixed stars.

Fraunhofer has noticed that two bright lines appear in the spectrum of a candle flame, which coincide with the two dark lines D of the solar spectrum. The same bright lines are obtained with greater intensity from a flame to which cooking salt has been added. I designed a solar spectrum, letting the sunbeams pass through a strong salt flame before they fell on the gap. When the sunlight was sufficiently subdued, two light lines appeared in place of the two dark lines; if the intensity exceeded that but a certain limit, then the two dark lines D appeared in much greater clarity, as if the presence of the common salt flame were unknown.

The spectrum of Drummond's light usually contains the two bright sodium lines, when the luminous part of the lime cylinder has not yet been exposed to the heat of glowing; if the lime cylinder remains unchanged, these lines become weaker and finally disappear altogether. When they have disappeared or are only weakly protruding, an alcoholic flame, into which salt has been brought, and which is placed between the lime cylinder and the gap, is replaced by two dark lines of excellent sharpness and fineness, which in every respect show the Lines D of the solar spectrum agree. Thus, the lines D of the solar spectrum are artificially induced in a spectrum in which they do not naturally occur.

Bringing chlorine into the flame of Bunsen's gas lamp, its spectrum shows a very bright, sharply delimited line lying in the middle of the Fraunhofer lines B and C. If one lets sunbeams of moderate intensity fall through the flame onto the gap, then at the designated place the line is bright on a darker ground; but the intensity of sunlight is greater, a dark line appears in its place, which has quite the same character as the Fraunhofer. If you remove the flame, the line disappears completely, as far as I can see. I conclude from these observations that coloured lines, in which spectrum, sharp lines appear, rays of the colour lines as they pass through them, so that in place of the light lines, as soon as there is a light source beyond the flame of sufficient intensity, whose spectrum otherwise lacks these lines. In the glowing solar atmosphere, which produces bright lines in the same place in the spectrum of a flame. It may be assumed that the bright lines in the spectrum of a flame steeper with stem from a sodium content of the same; the dark lines D in the solar spectrum suggest that it is in the solar atmosphere. Brewster has found bright lines in the spectrum of the saltpetre flame at the location of the Fraunhofer lines A, a, B; these lines indicate a potassium content of the solar atmosphere. From my observation, according to which the lithium stripe does not correspond to a dark line in the solar spectrum, it does not follow in the atmosphere of the sun, or at least in a moderately small amount.

The investigation of the spectra of coloured flames has since gained a new and high interest; together with Bunsen, I will take it as far as our resources permit. In doing so, we will continue to explore the weakening of light rays in flames, as determined by my observations. In the

experiments which we have already undertaken in this direction, a fact has already arisen which seems to us of great importance. The Drummond's light requires a low-temperature sodium salt flame in order for dark lines to emerge in it. The flame of aqueous alcohol is suitable for this purpose, but not the flame of the Bunsen gas lamp. In the latter case, the smallest amount of common salt, as soon as it makes itself noticeable, causes the bright sodium lines to appear. We reserve the right to develop the consequences that can be attached to this fact.